REMARKS

Claims 1-29 are all the claims pending in the application. Claims 1-24 are rejected. Claims 25-29 are withdrawn from consideration. Claims 1, 11 and 19 are amended. Claims 10, 18 and 24 are cancelled.

Claim Rejections - 35 U.S.C. § 102

Claims 1-24 are rejected under 35 U.S.C. 102(e) as being anticipated by Shiota et al. (7,115,341) or Chan (6,682,861). This rejection is traversed for at least the following reasons.

The rejected claims include claims 1-10 directed to a method of producing a photomask in which a light-transmissive substrate is formed thereon with a chromium pattern. Claims 11-18 are directed to a photomask producing method for a halftone phase shift mask. Claims 19-24 are directed to a method of producing a chromeless-type phase shift mask.

As to the first set of method claims, the dry etching of the chromium film (2) is carried out under a condition selected from conditions that cause damage to the resist pattern (41) to a degree that is unallowable when etching said chromium film using the resist pattern as a mask. As to the second and third sets of method claims, a desired part of the whole of the chromium pattern is removed. The Examiner asserts that the claimed method is directed to solving a known problem with a known technique of using an etch protecting layer between the substrate layers and a resist layer.

In order to better emphasize the objects and advantages of the present invention, independent claims 1, 11 and 19 are now amended to state that, with respect to the step of forming the chromium pattern, "an etching rate of said chromium film is ten or more times an etching rate of said etching mask pattern and selection ratio of etching rate of inorganic-based etching mask pattern material/etching rate of resist is two or more."

In this regard, the Examiner is respectfully requested to recognize that a first object of the present invention is to provide a method that can (1) suppress the loading effect and (2) achieve a high CD accuracy when forming a highly accurate pattern by dry etching, in a photomask having a global opening ratio difference (variation in CD accuracy due to the loading effect becomes a problem), as explained at page 7, lines 3-7 of the specification.

In addition, a second object of the present invention is to provide a method of producing a photomask, which can form a pattern having a high CD accuracy regardless of the foregoing regions (over the hole surface of the mask) having a global opening ratio difference (variation in CD accuracy due to the loading effect becomes a problem) in the mask plane, and a photomask blank for use in the method, as explained at page 7, lines 8-13 of the specification.

Moreover, a third object of the present invention is to provide a method that can (1) suppress the loading effect and (2) achieve a high CD accuracy upon etching an opaque film as an etching mask layer when producing a halftone-type phase shift mask or a chromeless-type phase shift mask comprising a phase shift layer having a global opening ratio difference (variation in CD accuracy ratio due to the loading effect becomes a problem), as explained at page 7, lines 14-19 of the specification.

According to the present invention, in order to (1) suppress the loading effect and (2) achieve a high CD accuracy when forming a highly accurate pattern by dry etching, in a photomask having a global opening ratio difference (variation in CD accuracy due to the loading effect becomes a problem), it is necessary to carry out dry etching of the chromium film under a condition selected from conditions that cause damage to the resist pattern to a degree which is unallowable when etching the chromium film using the resist pattern as a mask, as taught on page 14, lines 8-11 of the specification. A condition that causes significant damage to the resist pattern occurs where etching anisotropy is high, as mentioned on page 14, lines 11-12 of the specification. Since increasing the anisotropy is a condition that facilitates damage to the resist pattern, it can not be employed in the conventional etching of the chromium film using the resist pattern as a mask, as mentioned on page 14, lines 16-18 of the specification. In addition, it is impossible to suppress the loading effect and to achieve a high CD accuracy when forming a highly accurate pattern by dry etching, in a photomask having a global opening ratio difference where only the etching mask pattern is used as a mask.

However, according to the present invention, etching under a condition where (1) etching anisotropy is high and (2) the etching mask pattern is used as a mask, causes an increase in perpendicularity of the pattern sectional shape. In addition, variation in CD shift in the mask plane is reduced, despite a variation in etching rate in the mask plane due to some loading effect,

since side etching of the pattern is reduced, as mentioned on page 14, lines 21-25 of the specification. Further since the side etching amount of the pattern is small relative to the over all etching that is carried out for making the sectional shape of the chromium film pattern perpendicular, the CD shift of the pattern due to the over etching can be better controlled as compared to the conventional technique, as taught on page 14, line 25 to page 15, line 1 of the specification.

Accordingly, in the present invention, as one of conditions where etching anisotropy is high, constituent feature is added that in the step of forming the chromium pattern, an etching rate of the chromium film is **ten or more** times an etching rate of said etching mask pattern and the selection ratio of the etching rate of inorganic-based etching mask pattern material/etching rate of resist is **two or more** (cf. page 10, lines 24-26 and page 13, lines 4-7 of the specification). As already noted, the claims have been amended to expressly state this limitation.

Shota et al

The Examiner asserts that Shota et al. teach the originally claimed invention. Specifically, the Examiner points to the production of a halftone phase shift mask blank for use in comprising a transparent substrate, a light transmitting portion formed on the substrate for transmitting an exposure light beam, a phase shifter portion formed on the substrate for transmitting a part of the exposure light beam as a transmitted light beam and for shifting a phase of the transmitted light beam by a predetermined amount, and a phase shifter film for forming the phase shifter portion. The Examiner also asserts that the phase shifter film comprises a film containing silicon, oxygen, and nitrogen as main components and an etching stopper film formed between the film and transparent substrate.

Applicants respectfully submit that, while Shiota et al. may teach a halftone phase shift mask blank for use in manufacturing a halftone phase shift mask with the above noted features, the reference is deficient with respect to the presently claimed invention. In Shiota et al., the light shielding Cr layer is formed on the phase shift mask blank, and the resist pattern is formed on the shielding Cr layer to obtain a light shielding Cr pattern (see, column 12, lines 45-48, Figs. 3A and 3B, Figs. 4A and 4B, Figs. 5B to 5C, and Figs. 6A to 6C). However, Shiota et al. neither discloses nor teaches an etching mask pattern (31) formed on a chromium film (2) serving as the

shield film as the present invention. Accordingly, Shiota at al. cannot make perpendicular the sectional shape of the chromium film pattern.

Chan

The Examiner asserts that Chan teaches the claimed invention and further notes that Chan's teachings are directed to the same object as applicant's, which is to provide a blank photomask that includes a layer of hard mask material thereby enabling the critical dimensions of a finished photomask to be more uniform. The Examiner notes that where the hard mask layer comprises Si, the step of removing exposed portions of the hard mask layer is conducted using plasma gases, the composition of which has either fluorine, chlorine, bromine containing species or a combination of various halide containing species. The Examiner further notes that where the hard mask layer is selected from the list comprised of Ti, TiW, W, Si_3N_4, SiO_2, TiN and spin-on-glass, and the step of removing exposed portions of the hard mask layer is conducted using plasma gases, the composition of which has either fluorine, chlorine, or bromine containing species or a combination of various halide containing species.

However, Applicants respectfully submit that despite the cited teachings, Chan further requires a black photomask 30 comprising a quartz substrate 2, a layer of Cr opaque material 4 affixed to the quartz substrate, an integral layer of CrO AR material 6 formed on the top of Cr opaque material 4, a hard mask layer 18 deposited on top of the CrO AR material 6, and the layer of photosensitive resist material 8 (see, column 6, lines 35-60 and Fig. 5). Given the foregoing teaching, it would be impossible to suppress the loading effect and to achieve a high CD accuracy when forming a highly accurate pattern by dry etching, in a photomask having a global opening ratio difference in a case of only using the etching mask pattern as a mask. Further, Chan neither discloses nor teaches the above-mentioned one of conditions where etching anisotropy is high, namely, in the step of forming said chromium pattern, an etching rate of said chromium film is ten or more times an etching rate of said etching mask pattern and selection ratio of etching rate of inorganic-based etching mask pattern material/etching rate of resist is two or more.

Claims 19-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nyhus et al. (2004/0101764) in view of Shiota et al. (7,115,341) or Chan (6,682,861). This rejection is traversed for at least the following reasons.

Nyhus et al

The Examiner asserts that Nyhus et al. teach a chromeless type phase shift mask and the importance of the CD. As shown in FIG. 5B, under the same stepper conditions, CPL contact patterning enables contacts with finer critical dimensions (e.g., diameter) to be formed when compared with the conventional binary mask techniques. Thus, existing steppers may be used to form contact patterns having feature sizes and grid densities finer than could be patterned with those steppers under conventional contact patterning techniques. The Examiner admits that Nyhus et al. differs from the invention with respect to the use of an etch protecting layer. The Examiner notes the teachings of Shiota et al. and Chan, and asserts that it would have been obvious to one having ordinary skill in the art to take the teachings of Nyhus et al. and combine them with the teachings of Shiota et al. or Chan in order to make the claimed invention. The rationale is that one would take advantage of the teachings of Shiota et al. or Chan and incorporate the additional inorganic etch protective layer in order to produce a mask with better CD.

Applicants respectfully submit that, even though Nyhus et al. may teach a chromeless phase shift mask, Nyhus et al. neither discloses nor teaches an etching mask pattern (31) formed on a chromium film (2) serving as the shield film as in the present invention. Moreover, Nyhus et al does not teach the above-mentioned one of conditions where etching anisotropy is high.

Accordingly, although Shiota et al., Chan, and Nyhus et al. are combined with one another, it would be impossible to (1) suppress the loading effect and (2) achieve a high CD accuracy when forming a highly accurate pattern by dry etching, in a photomask having a global opening ratio difference.

Conclusion

Applicants respectfully submit that amended claims 1, 11, and 19 should be allowable for the reasons given. Claims 2-9 are dependent from amended claim 1, claims 12-17 are dependent

from amended claim 11, and claims 20-23 are dependent from amended claim 19. Therefore, all of the claims 1-8, 11-17, and 19-23 should also be allowable.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

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Date: July 23, 2007